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"STUB" EXTERIOR GATEWAY PROTOCOL

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This note describes the Exterior Gateway Protocol used to connect Stub Gateways to an Autonomous System of core Gateways. This document specifies the working protocol, and defines an ARPA official protocol. All implementers of Gateways should carefully review this document.

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1 INTRODUCTION

The DARPA Catenet is expected to be a continuously expanding system, with more and more hosts on more and more networks participating in it. Of course, this will require more and more gateways. In the past, such expansion has taken place in a relatively unstructured manner. New gateways, often containing radically different software than the existing gateways, would be added and would immediately begin participating in the common routing algorithm via the GGP protocol. However, as the internet grows larger and larger, this simple method of expansion becomes less and less feasible. There are a number of reasons for this:

- the overhead of the routing algorithm becomes excessively large;
- the proliferation of radically different gateways participating in a single common routing algorithm makes maintenance and fault isolation nearly impossible, since it becomes impossible to regard the internet as an integrated communications system;
- the gateway software and algorithms, especially the routing algorithm, become too rigid and inflexible, since

any proposed change must be made in too many different places and by too many different people.

In the future, the internet is expected to evolve into a set of separate sections or "autonomous systems", each of which consists of a set of one or more relatively homogeneous gateways. The protocols, and in particular the routing algorithm which these gateways use among themselves, will be a private matter, and need never be implemented in gateways outside the particular sections or system.

In the simplest case, an autonomous system might consist of just a single gateway connecting, for example, a local network to the ARPANET. Such a gateway might be called a "stub gateway", since its only purpose is to interface the local network to the rest of the internet, and it is not intended to be used for handling any traffic which neither originated in nor is destined for that particular local network. In the near-term future, we will begin to think of the internet as a set of autonomous systems, one of which consists of the DARPA gateways on ARPANET and SATNET, and the others of which are stub gateways to local networks. The former system, which we shall call the "core"

system, will be used as a transport or "long-haul" system by the latter systems.

Ultimately, the internet may consist of a number of co-equal autonomous systems, any of which may be used as a transport medium for traffic originating in any system and destined for any system. This more general case is still the subject of research. This paper describes only how stub gateways connect to the core system using the Exterior Gateway Protocol (EGP).

2 DEFINITIONS AND OVERVIEW

For the purposes of this paper, a "stub gateway" is defined as follows:

- it is not a core gateway
- it shares a network with at least one core gateway (has an interface on the same network as some core gateway)
- it has interfaces to one or more networks which have no core gateways
- all other nets which are reachable from the core system via the stub have no other path to the core system except via the stub

The stub gateway is expected to fully execute the Internet Control Message Protocol (ICMP), as well as the EGP protocol. In particular, it must respond to ICMP echo requests, and must send ICMP destination dead messages as appropriate. It is also required to send ICMP Redirect messages as appropriate.

Autonomous systems will be assigned 16-bit identification numbers (in much the same ways as network and protocol numbers are now assigned), and every EGP message header contains a field

for this number. Zero will not be assigned to any autonomous system; the use of zero as an autonomous system number is reserved for future use.

We call two gateways "neighbors" if there is a network to which each has an interface. If two neighbors are part of the same autonomous system, we call them INTERIOR NEIGHBORS; for example, any two core gateways on the same network are interior neighbors of each other. If two neighbors are not part of the same autonomous system, we call them EXTERIOR NEIGHBORS; for example, a stub gateway and any core gateway that share a network are exterior neighbors of each other. In order for one system to use another as a transport medium, gateways which are exterior neighbors of each other must be able to find out which networks can be reached through the other. The Exterior Gateway Protocol enables this information to be passed between exterior neighbors. Since it is a polling protocol, it also enables each gateway to control the rate at which it sends and receives network reachability information, allowing each system to control its own overhead. It also enables each system to have an independent routing algorithm whose operation cannot be disrupted by failures of other systems.

The Exterior Gateway Protocol has three parts: (a) Neighbor Acquisition Protocol, (b) Neighbor Reachability Protocol, and (c) Network Reachability determination. Note that all messages defined by EGP are intended to travel only a single "hop". That is, they originate at one gateway and are sent to a neighboring gateway without the mediation of any intervening gateway. Therefore, the time-to-live field should be set to a very small value. Gateways which encounter EGP messages in their message streams which are not addressed to them may discard them.

Each EGP message contains a sequence number. The gateway should maintain one sequence number per neighbor.

3 NEIGHBOR ACQUISITION

Before it is possible to obtain routing information from an exterior gateway, it is necessary to acquire that gateway as a direct neighbor. (The distinction between direct and indirect neighbors will be made in a later section.) In order for two gateways to become direct neighbors, they must be neighbors, in the sense defined above, and they must execute the NEIGHBOR ACQUISITION PROTOCOL, which is simply a standard two-way handshake.

A gateway that wishes to initiate neighbor acquisition with another sends it a Neighbor Acquisition Request. This message should be repeatedly transmitted (at a reasonable rate, perhaps once every 30 seconds or so) until a Neighbor Acquisition Reply or a Neighbor Acquisition Refusal is received. The Request will contain an identification number which is copied into the reply so that request and reply can be matched up.

A gateway receiving a Neighbor Acquisition Request must determine whether it wishes to become a direct neighbor of the source of the Request. If not, it may, at its option, respond with a Neighbor Acquisition Refusal message, optionally specifying the reason for refusal. Otherwise, it should send a

Neighbor Acquisition Reply message.

The gateway that sent the Request should consider the Neighbor Acquisition complete when it has received the neighbor's Reply. The gateway that sent the Reply should consider the acquisition complete when it has sent the Reply.

Unmatched Replies or Refusals should be discarded after a reasonable period of time. However, information about any such unmatched messages may be useful for diagnostic purposes.

A Neighbor Acquisition Request from a gateway which is already a direct neighbor should be responded to with a Reply.

A Neighbor Acquisition Request or Reply from gateway G to gateway G' carries the minimum interval in seconds with which G is willing to answer Neighbor Reachability Hello Messages from G' and the minimum interval in seconds with which G is willing to be polled for NR messages (see below).

If a gateway wishes to cease being a neighbor of a particular exterior gateway, it sends a Neighbor Cease message. A gateway receiving a Neighbor Cease message should always respond with a Neighbor Cease Acknowledgment. It should cease to treat the sender of the message as a neighbor in any way. Since

there is a significant amount of protocol run between direct neighbors (see below), if some gateway no longer needs to be a direct neighbor of some other, it is "polite" to indicate this fact with a Neighbor Cease Message. The Neighbor Cease Message should be retransmitted (up to some number of times) until an acknowledgment for it is received.

Once a Neighbor Cease message has been received, the Neighbor Reachability Protocol (below) should cease to be executed.

A stub should have tables configured in with the addresses of a small number of the core gateways (no more than two or three) with which it has a common network. It will be the responsibility of the stub to initiate neighbor acquisition with these gateways. If the direct neighbors of a stub should all fail, it will be the responsibility of the stub to acquire at least one new direct neighbor. It can do so by choosing one of the core gateways which it has had as an indirect neighbor (see below), and executing the neighbor acquisition protocol with it. (It is possible that no more than one core gateway will ever agree to become a direct neighbor with any given stub gateway at any one time.)

4 NEIGHBOR REACHABILITY PROTOCOL

It is important for a gateway to keep real-time information as to the reachability of its neighbors. If a gateway concludes that a particular neighbor cannot be reached, it should cease forwarding traffic to that gateway. To make that determination, a NEIGHBOR REACHABILITY protocol is needed. The EGP protocol provides two messages types for this purpose -- a "Hello" message and an "I Heard You" message.

When a "Hello" message is received from a direct neighbor, an "I Heard You" must be returned to that neighbor "immediately". The delay between receiving a "Hello" and returning an "I Heard You" should never be more than a few seconds.

Core gateways will use the following algorithm for determining reachablility of an exterior neighbor:

A reachable neighbor shall be declared unreachable if, during the time in which the core gateway sent its last n "Hello"s, it received fewer than k "I Heard You"s in return. An unreachable neighbor shall be declared reachable if, during the time in which the core gateway sent its last m "Hello"s, it received at least j "I Heard You"s in return.

Stub gateways may also send "Hello"s to their direct neighbors and receive "I Heard You"s in return. The algorithm for determining reachability may be similar to the algorithm described above. However, it is not necessary for stubs to send "Hello"s. The "Hello" and "I Heard You" messages have a status field which the sending gateway uses to indicate whether it thinks the receiving gateway is reachable or not. This information can be useful for diagnostic purposes. It also allows a stub gateway to make its reachability determination parasitic on its core neighbor: only the core gateway actually needs to send "Hello" messages, and the stub can declare it up or down based on the status field in the "Hello". That is, the stub gateway (which sends only "I Heard You"s) declares the core gateway (which sends only "Hello"s) to be reachable when the "Hello"s from the core indicate that it has declared the stub to be reachable.

The frequency with which the "Hello"s are sent, and the values of the parameters k, n, j, and m cannot be specified here. For best results, this will depend on the characteristics of the neighbor and of the network which the neighbors have in common. THIS IMPLIES THAT THE PROPER PARAMETERS MAY NEED TO BE DETERMINED JOINTLY BY THE DESIGNERS AND IMPLEMENTERS OF THE TWO NEIGHBORING

GATEWAYS; choosing algorithms and parameters in isolation, without considering the characteristics of the neighbor and the connecting network, would not be expected to result in optimum reachability determinations.

However, the Neighbor Acquisition Request and Reply messages provide neighbors with a way to inform each other of the minimum frequency at which they are willing to answer Hellos. When gateway G sends a Neighbor Acquisition Request to gateway G', it states that it does not wish to answer Hellos from G' more frequently than once every X seconds. G' in its Neighbor Acquisition Reply states that it does not wish to answer Hellos from G more frequently than once every Y seconds. The two frequencies do not have to be the same, but each neighbor must conform to the interval requested by the other. A gateway may send Hellos less frequently than requested, but not more.

A direct neighbor gateway should also be declared unreachable if the network connecting it supplies lower level protocol information from which this can be deduced. Thus, for example, if a gateway receives an 1822 Destination Dead message from the ARPANET which indicates that a direct neighbor is dead, it should declare that neighbor unreachable. The neighbor should

not be declared reachable again until the requisite number of Hello/I-Heard-You packets have been exchanged.

A direct neighbor which has become unreachable does not thereby cease to be a direct neighbor. The neighbor can be declared reachable again without any need to go through the neighbor acquisition protocol again. However, if the neighbor remains unreachable for an extremely long period of time, such as an hour, the gateway should cease to treat it as a neighbor, i.e., should cease sending Hello messages to it. The neighbor acquisition protocol would then need to be repeated before it could become a direct neighbor again.

"Hello" messages from sources other than direct neighbors should simply be ignored. However, logging the presence of any such messages might provide useful diagnostic information.

A gateway which is going down, or whose interface to the network which connects it to a particular neighbor is going down, should send a Neighbor Cease message to all direct neighbors which will no longer be able to reach it. The Cease message should use the info field to specify the reason as "going down". It should retransmit that message (up to some number of times) until it receives a Neighbor Cease Acknowledgment. This provides

the neighbors with an advance warning of an outage, and enables them to prepare for it in a way which will minimize disruption to existing traffic.

5 NETWORK REACHABILITY (NR) MESSAGE

Terminology: Let gateway G have an interface to network N. We say that G is AN APPROPRIATE FIRST HOP to network M relative to network N (where M and N are distinct networks) if and only if the following condition holds:

> Traffic which is destined for network M, and which arrives at gateway G over its network N interface, will be forwarded to M by G over a path which does not include any other gateway with an interface to network N.

In short, G is an appropriate first hop for network M relative to network N just in case there is no better gateway on network N through which to route traffic which is destined for network M. For optimal routing, traffic in network N which is destined for network M ought always to be forwarded to a gateway which is an appropriate first hop.

In order for exterior neighbors G and G' (which are neighbors over network N) to be able to use each other as packet switches for forwarding traffic to remote networks, each needs to know the list of networks for which the other is an appropriate first hop. The Exterior Gateway Protocol defines a message,

called the Network Reachability Message (or NR message), for transferring this information.

Let G be a gateway on network N. Then the NR message which G sends about network N must contain the following information:

A list of all the networks for which G is an appropriate first hop relative to network N.

If G' can obtain this information from exterior neighbor G, then it knows that no traffic destined for networks which are NOT in that list should be forwarded to G. (It cannot simply conclude, however, that all traffic for any networks in that list ought to be forwarded via G, since G' may also have other neighbors which are also appropriate first hops to network N. For example, G and G'' might each be neighbors of G', but might be "equidistant" from some network M. Then each could be an appropriate first hop.)

For each network in the list, the NR message also specifies the "distance" (according to some metric whose definition is left to the designers of the autonomous system of which gateway G is a member) from G to that network. Core gateways will report distances less than 128 for networks that can be reached without

leaving the core system, and greater than or equal to 128 otherwise. A stub gateway should report distances less than 128 for all networks listed in its NR messages.

The maximum value of distance (255.) shall be taken to mean that the network is UNREACHABLE. ALL OTHER VALUES WILL BE TAKEN TO MEAN THAT THE NETWORK IS REACHABLE.

If an NR message from some gateway G fails to mention some network N which was mentioned in the previous NR message from G, it is possible that N has become unreachable from G. If several successive NR messages from G omit mention of N, it should be taken to mean that N is no longer reachable from G. This procedure is necessary to ensure that networks which can no longer be reached, but which are never explicitly declared unreachable, are timed out and removed from the list of reachable networks.

It will often be the case that where a core gateway G and a stub gateway G' are direct neighbors on network N, G knows of many more gateway neighbors on network N, and knows for which networks those gateway neighbors are the appropriate first hop. Since the stub G' may not know about all these other neighbors, it is convenient and often more efficient for it to be able to

obtain this information from G. Therefore, the EGP NR message also contains fields which allow the core gateway G to specify the following information:

a) A list of all neighbors (both interior and exterior) of G (on network N) which G has reliably determined to be reachable. G may also include indirect neighbors in this list (see below.)

b) For each of those neighbors, the list of networks for which that neighbor is an appropriate first hop (relative to network N).

c) For each such <neighbor, network> pair, the "distance" from that neighbor to that network.

Thus the NR message provides a means of allowing a gateway to "discover" new neighbors by seeing whether a neighbor that it already knows of has any additional neighbors on the same network. This information also makes possible the implementation of the INDIRECT NEIGHBOR strategy defined below.

A more precise description of the NR message is the following.

The data portion of the message will consist largely of blocks of data. Each block will be headed by a gateway address, which will be the address either of the gateway sending the message or of one of that gateway's neighbors. Each gateway address will be followed by a list of the networks for which that gateway is an appropriate first hop. All networks at the same distance from the gateway will be grouped together in this list, preceded by the distance itself and the number of networks at that distance. The whole list is preceded by a count of the distance-groups in the list.

Preceding the list of data blocks is:

a) The count (one byte) of the number of interior neighbors of G for which this message contains data blocks. By convention, this count will include the data block for G itself, which should be the first one to appear.

b) The count (one byte) of the number of exterior neighbors of G for which this message contains data blocks.

c) The address of the network which this message is about. If G and G' are neighbors on network N, then in the NR message going from G to G', this is the address of

network N. For convenience, four bytes have been allocated for this address -- the trailing one, two, or three bytes should be zero.

Then follow the data blocks themselves, first the block for G itself, then the blocks for all the interior neighbors of G (if any), then the blocks for the exterior neighbors. Since all gateways mentioned are on the same network, whose address has already been given, the gateway addresses are given with the network address part (one, two, or three bytes) omitted, to save space.

In the list of networks, each network address is either one, two, or three bytes, depending on whether it is a class A, class B, or class C network. No trailing bytes are used.

The NR message sent by a stub should be the simplest allowable. That is, it should have only a single data block, headed by its own address (on the network it has in common with the neighboring core gateway), listing just the networks to which it is an appropriate first hop. These will be just the networks that can be reached no other way, in general.

The core gateways will send complete NR messages, containing information about all other gateways on the common network, both core gateways (which shall be listed as interior neighbors) and other gateways (which shall be listed as exterior neighbors, and may include the stub itself). This information will enable the stub to become an indirect neighbor (see below) of all these other gateways. That is, the stub shall forward traffic directly to these other gateways as appropriate, but shall not become direct neighbors with them.

The stub should NEVER forward to any (directly or indirectly) neighboring core gateway any traffic for which that gateway is not an appropriate first hop, as indicated in an NR message. Of course, this does not apply to datagrams which are using the source route option; any such datagrams should always be forwarded as indicated in the source route option field, even if that requires forwarding to a gateway which is not an appropriate first hop.

6 POLLING FOR NR MESSAGES

No gateway is required to send NR messages to any other gateway, except as a response to an NR Poll from a direct neighbor. However, a gateway is required to respond to an NR Poll from a direct neighbor within several seconds (subject to the qualification two paragraphs hence), even if the gateway believes that neighbor to be down.

The EGP NR Poll message is defined for this purpose. No gateway may poll another for an NR message more often than once per minute. A gateway receiving more than one poll per minute may simply ignore the excess polls, or may return an error message.

The minimum interval which gateway G will accept as the polling interval from gateway G' and the minimum interval which G' will accept as the polling interval from G are specified at the time that G and G' become direct neighbors. Both the Neighbor Acquisition Request and the Neighbor Acquisition Reply allow the sender to specify, in seconds, its desired minimum polling interval. If G specifies to G' that its minimum polling interval is X, G' should not poll G more frequently than once every X seconds. G will not guarantee to answer more frequent

polls.

Polls must only be sent to direct neighbors which are declared reachable by the neighbor reachability protocol.

An NR Poll message contains a sequence number chosen by the polling gateway. The polled gateway will return this number in the NR message it sends in response to the poll, to enable the polling gateway to match up received NR messages with polls.

In general, a poll should be retransmitted some number of times (with a reasonable interval between retransmissions) until an NR message is received. IF NO NR MESSAGE IS RECEIVED AFTER THE MAXIMUM NUMBER OF RETRANSMISSIONS, THE POLLING GATEWAY SHOULD ASSUME THAT THE POLLED GATEWAY IS NOT AN APPROPRIATE FIRST HOP FOR ANY NETWORK WHATSOEVER. The optimum parameters for the polling/retransmission algorithm will be dependent on the characteristics of the two neighbors and of the network connecting them.

Received NR messages whose identification numbers do not match the identification number of the most recently sent poll shall be ignored. There is no provision for multiple outstanding polls to the same neighbor.

7 SENDING NR MESSAGES

In general, NR messages are to be sent only in response to a poll. However, between two successive polls from an exterior neighbor, a gateway may send one and only one unsolicited NR message to that neighbor. This gives it limited ability to quickly announce network reachability changes that may have occurred in the interval since the last poll. Excess unsolicited NR messages may be ignored, or an error message may be returned.

An NR message should be sent within several seconds after receipt of a poll. Failure to respond in a timely manner to an NR poll may result in the polling gateway's deciding that the polled gateway is not an appropriate first hop to any network.

NR messages sent in response to polls carry the sequence number of the poll message in their "sequence number" fields. Unsolicited NR messages carry the identification number of the last poll received, and have the "unsolicited" bit set. (Note that this allows for only a single unsolicited NR message per polling period.)

Polls from non-neighbors, from neighbors which are not declared reachable, or with bad IP source network fields, should

be responded to with an EGP error message with the appropriate "reason" field. If G sends an NR poll to G' with IP source network N, and G' is not a neighbor of G on its interface to network N (or G' does not have an interface to network N), then the source network field is considered "bad".

A gateway is normally not required to send more than one NR message within the minimum interval specified at the time of the neighbor acquisition. An exception to this must be made for duplicate polls (successive polls with the same sequence number), which occur when an NR message is lost in transit. A gateway should send an NR message containing its most recent information in response to a duplicate poll.

8 INDIRECT NEIGHBORS

Becoming a "direct neighbor" of an exterior gateway requires three steps: (a) neighbor acquisition, (b) running a neighbor reachability protocol, and (c) polling the neighbor periodically for NR messages. Suppose, however, that gateway G receives an NR message from G', in which G' indicates the presence of other neighbors G1, ..., Gn, each of which is an appropriate first hop for some set of networks to which G' itself is not an appropriate first hop. Then G should be allowed to forward traffic for those networks directly to the appropriate one of G1, ..., Gn, without having to send it to G' first. In this case, G may be considered an INDIRECT NEIGHBOR of G1, ..., Gn, since it is a neighbor of these other gateways for the purpose of forwarding traffic, but does not perform neighbor acquisition, neighbor reachability, or exchange of NR messages with them. Neighbor and network reachability information is obtained indirectly via G', hence the designation "indirect neighbor". We say that G is an indirect neighbor of G1, ..., Gn VIA G'.

If G is an indirect neighbor of G' via G'', and then G receives an NR message from G'' which does not mention G', G should treat G' as having become unreachable.

9 LIMITATIONS

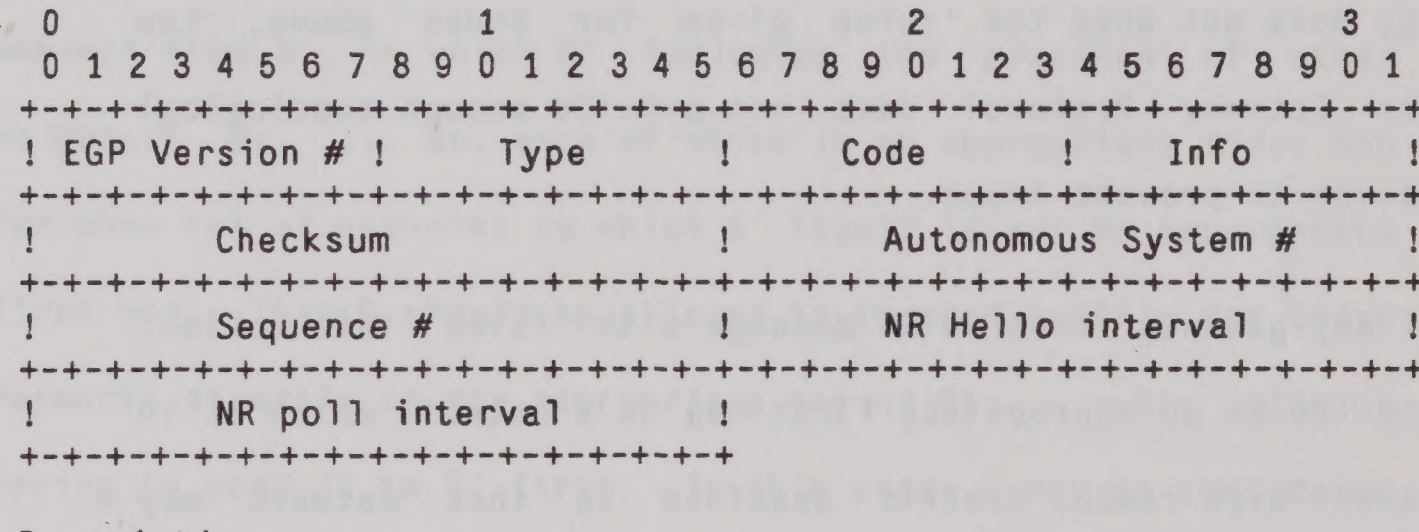
It must be clearly understood that the Exterior Gateway Protocol does not in itself constitute a network routing algorithm. In addition, it does not provide all the information needed to implement a general area routing algorithm. If the topology does not obey the rules given for stubs above, the Exterior Gateway Protocol does not provide enough topological information to prevent loops.

If any gateway sends an NR message with false information, claiming to be an appropriate first hop to a network which it in fact cannot even reach, traffic destined to that network may never be delivered. Implementers must bear this in mind.

A APPENDIX A - EGP MESSAGE FORMATS

The Exterior Gateway Protocol runs under Internet Protocol as protocol number 8 (decimal).

A.1 NEIGHBOR ACQUISITION MESSAGE


0 1 2 3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
EGP Version #
Type
Code
Info
Checksum
Autonomous System #
Sequence #
NR Hello interval
NR poll interval

Description:

The Neighbor Acquisition messages are used by interior and exterior gateways to become neighbors of each other.

EGP Version #

2

Type

3

Code

Code = 0	Neighbor Acquisition Request
Code = 1	Neighbor Acquisition Reply
Code = 2	Neighbor Acquisition Refusal (see Info field)
Code = 3	Neighbor Cease Message (see Info field)
Code = 4	Neighbor Cease Acknowledgment

Checksum

The EGP checksum is the 16-bit one's complement of the one's complement sum of the EGP message starting with the EGP version number field. For computing the checksum, the checksum field should be zero.

Autonomous System #

This 16-bit number identifies the autonomous system containing the gateway which is the source of this message.

Info

For Refusal message, gives reason for refusal:

0 Unspecified
1 Out of table space
2 Administrative prohibition

For Cease message, gives reason for ceasing to be neighbor:

0 Unspecified
1 Going down
2 No longer needed

Otherwise, this field MUST be zero.

Sequence Number

A sequence number to aid in matching requests and replies.

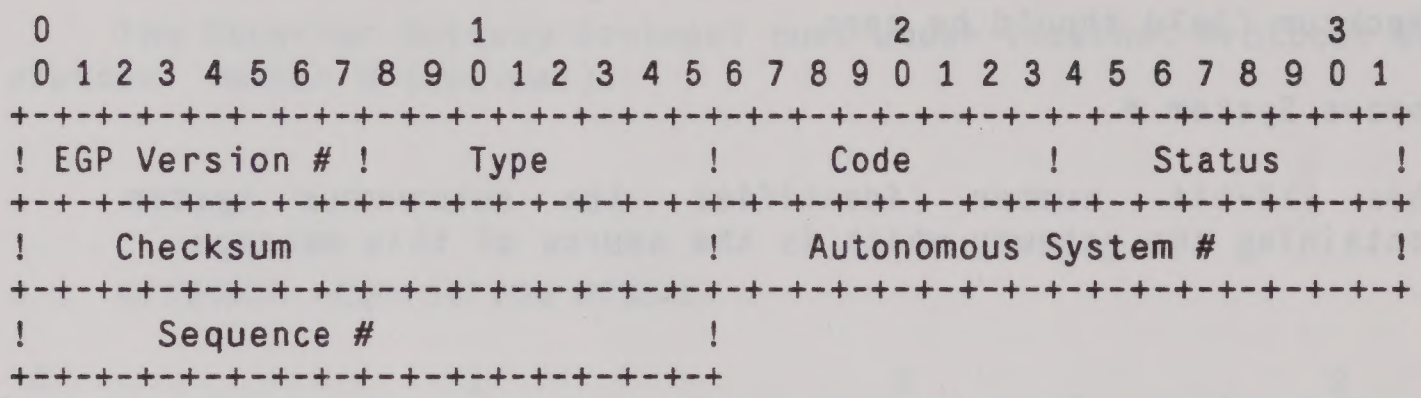
NR Hello Interval

Minimum Hello polling interval(seconds).

NR Poll Interval

Minumum NR polling interval(seconds).

A.2 NEIGHBOR HELLO/I HEARD YOU MESSAGE



Description:

Exterior neighbors use EGP Neighbor Hello and I Heard You Messages to determine neighbor connectivity. When a gateway receives an EGP Neighbor Hello message from a neighbor it should respond with an EGP I Heard You message.

EGP Version #

2

Type

5

Code

Code = 0 for Hello
Code = 1 for I Heard you

Checksum

The EGP checksum is the 16-bit one's complement of the one's complement sum of the EGP message starting with the EGP version number field. For computing the checksum, the checksum field should be zero.

Autonomous System #

This 16-bit number identifies the autonomous system containing the gateway which is the source of this message.

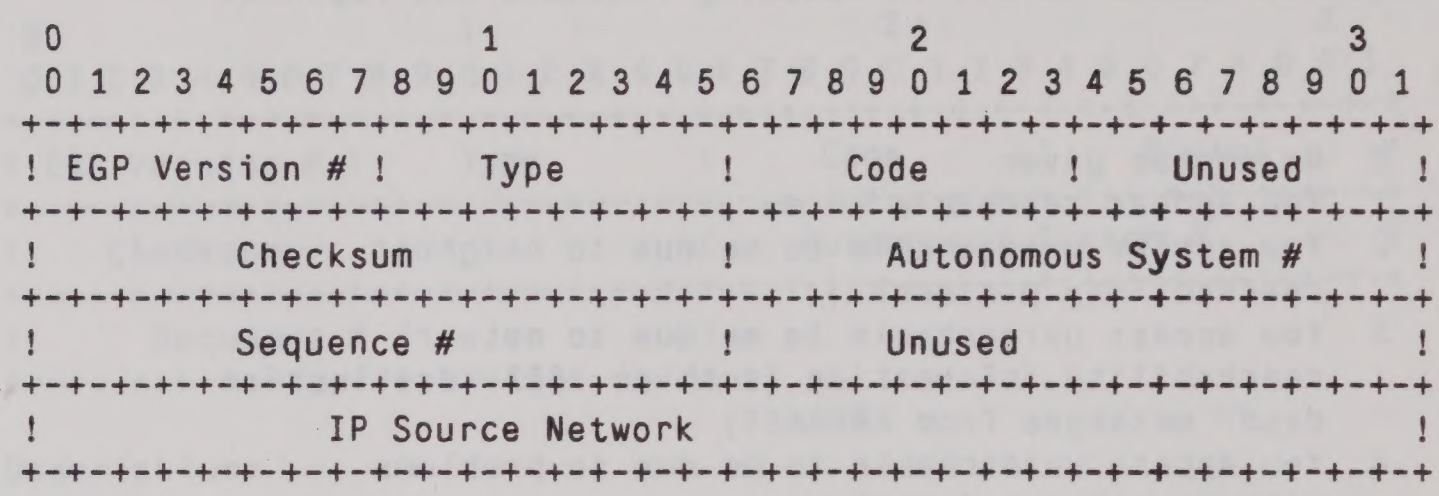
Sequence Number

A sequence number to aid in matching requests and replies.

Status

0 No status given
1 You appear reachable to me
2 You appear unreachable to me due to neighbor reachability protocol
3 You appear unreachable to me due to network reachability information (such as 1822 "destination dead" messages from ARPANET)
4 You appear unreachable to me due to problems with my network interface

A.3 NR POLL MESSAGE


0 1 2 3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
EGP Version # ! Type ! Code ! Unused !
Checksum ! Autonomous System # !
Sequence # ! Unused !
IP Source Network

Description:

A gateway that wants to receive an NR message from an Exterior Gateway will send an NR Poll message. Each gateway mentioned in the NR message will have an interface on the network that is in the IP source network field.

EGP Version #

2

Type

2

Code

0

Checksum

The EGP checksum is the 16-bit one's complement of the one's complement sum of the EGP message starting with the EGP version number field. For computing the checksum, the checksum field should be zero.

Autonomous System #

This 16-bit number identifies the autonomous system

containing the gateway which is the source of this message.

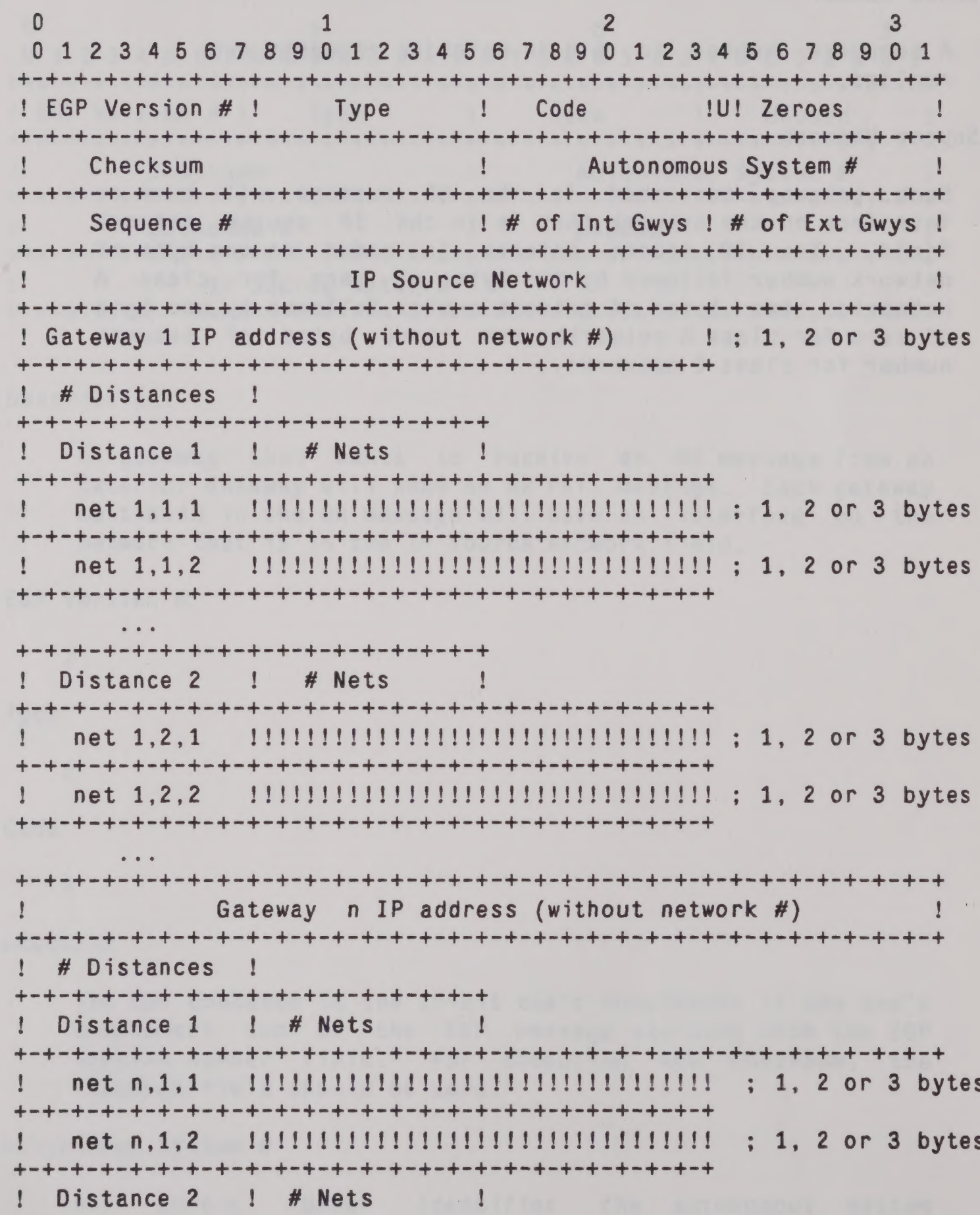
Sequence Number

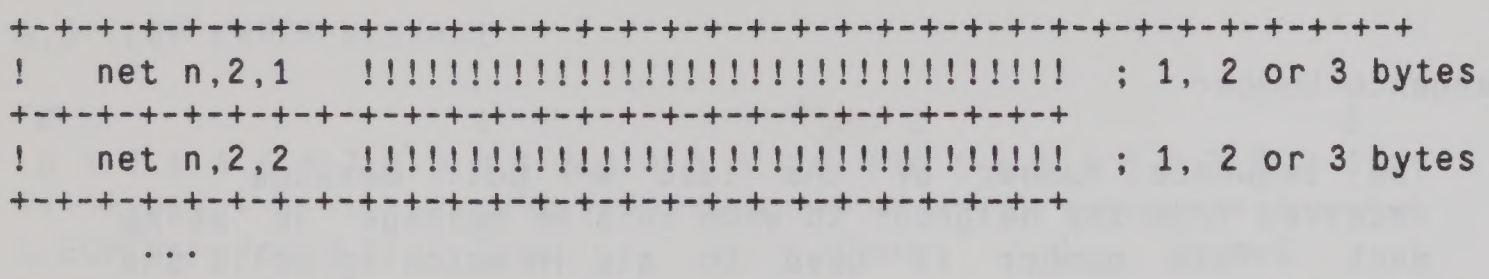
A sequence number to aid in matching requests and replies.

IP Source Network

Each gateway mentioned in the NR message will have an interface on the network that is in the IP source network field. The IP source network is coded as one byte of network number followed by two bytes of zero for class A networks, two bytes of network number followed by one byte of zero for class B networks, and three bytes of network number for class C networks.

A.4 NETWORK REACHABILITY MESSAGE





...

Description:

The Network Reachability message (NR) is used to discover which networks may be reached through Exterior Gateways. The NR message is sent in response to an NR Poll message.

EGP Version #

2

Type

1

Code

0

Checksum

The EGP checksum is the 16-bit one's complement of the one's complement sum of the EGP message starting with the EGP version number field. For computing the checksum, the checksum field should be zero.

Autonomous System #

This 16-bit number identifies the autonomous system containing the gateway which is the source of this message.

U (Unsolicited) bit

This bit is set if the NR message is being sent unsolicited.

Sequence Number

The sequence number of the last NR poll message received from the neighbor to whom this NR message is being sent. This number is used to aid in matching polls and replies.

IP Source Network

Each gateway mentioned in the NR message will have an interface on the network that is in the IP source network field.

# of Interior Gateways

The number of interior gateways that are mentioned in this message.

# of Exterior Gateways

The number of exterior gateways that are mentioned in this message.

Gateway IP address

1, 2 or 3 bytes of Gateway IP address (without network #).

# of Distances

The number of distances in the gateway block.

Distance

The distance.

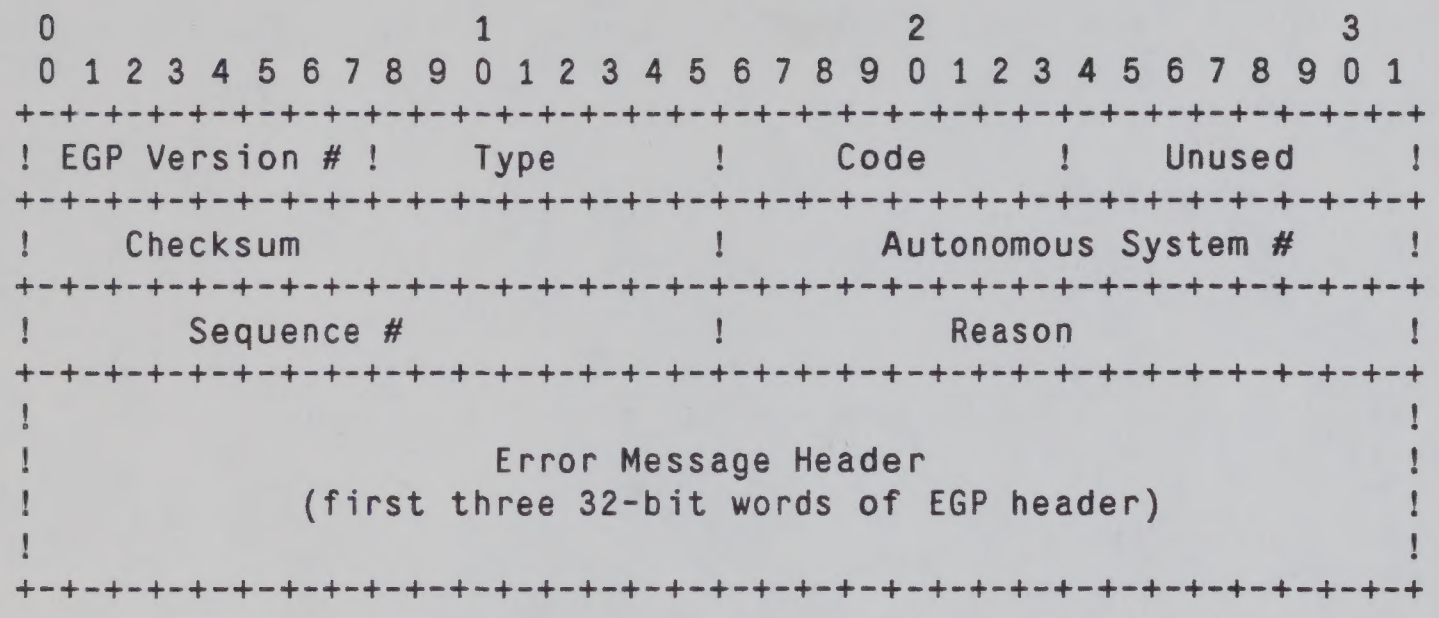
# of Nets

The number of nets at this distance.

Network address

1, 2, or 3 bytes of network address of network which can be reached via the preceding gateway.

A.5 EGP ERROR MESSAGE


0 1 2 3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
EGP Version #
Type
Code
Unused
Checksum
Autonomous System #
Sequence #
Reason
Error Message Header
(first three 32-bit words of EGP header)

Description:

An EGP Error Message is sent in response to an EGP Message that has a bad checksum or has an incorrect value in one of its fields.

EGP Version #

2

Type

8

Code

0

Checksum

The EGP checksum is the 16-bit one's complement of the one's complement sum of the EGP message starting with the EGP version number field. For computing the checksum, the checksum field should be zero.

Autonomous System #

This 16-bit number identifies the autonomous system containing the gateway which is the source of this message.

Sequence Number

A sequence number assigned by the gateway sending the error message.

Reason

The reason that the EGP message was in error. The following reasons are defined:

0 - unspecified
1 - Bad EGP checksum
2 - Bad IP Source address in NR Poll or Response
3 - Undefined EGP Type or Code
4 - Received poll from non-neighbor
5 - Received excess unsolicted NR message
6 - Received excess poll
7 - Erroneous counts in received NR message
8 - No response received to NR poll